Space Weather Technical Forecast

Issued on Friday, 04 August 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares (R1-R2; Minor-Moderate radio blackouts) likely throughout. CME arrivals anticipated Days 1-3 (04-06 Aug) with a chance of G1/Minor Storm activity.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity over the past 24 hours has remained at Moderate levels with one Moderate class flare observed, peaking at M2.0 at 03/1147 UTC from AR3380 on the southwest limb. Nine numbered and one un-numbered sunspot region feature on the visible disc. The largest region is AR3380 (DAC/Beta-Gamma-Delta) on the southwest limb and remains unchanged. AR3386 (Dho/Beta) in the northwest and AR3392 (Eho/Beta) in the northeast are both the second largest regions and have also seen little significant change in recent hours, with minor reorganisation of the intermediate spots in both regions. New region AR3395 (Dso/Beta), emerging across the northeast limb, is showing some signs of complexity and will probably change as it rotates further into view. Remaining regions appear generally stable or in decay. A full-halo CME was observed leaving the Sun around 02/0900 UTC. This is expected to arrive at Earth either Late on day 2 (5th) UTC day or early on day 3 (6th). Also, two filament lift-offs from the northeast disc late 31 Jul (and observed on C2 imagery early 01 Aug) are considered to have Earth-directed components, arriving on the 4th or 5th.

Solar Wind / Geomagnetic Activity: The solar wind at L1, as measured by ACE, was slow-ambient, generally between 330 and 370 km/s. Density was near or rather above average, with a period peak reaching 17 ppcc around 03/1520 UTC, but fell below average later in the period. The total interplanetary magnetic field strength (Bt) was at weak levels to start becoming Moderate from 03/1430 UTC, with a peak of 10nT at 03/2055 UTC, with an upwards step change noted around 03/0930 UTC. The north-south component, Bz, was weak with a more prolonged southward directed orientation between 02/0400 UTC and 03/1600 UTC. Phi angle was initially negative (away from the Sun), becoming increasingly positive (towards the Sun). Geomagnetic activity was generally Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at mostly background levels, peaking at 126 pfu at 03/1855 UTC. The associated 24-hour integrated fluence remained below the Active level (1e8 integrated pfu), with 1.11e6 integrated pfu noted at 04/0000UTC, and now has a flat trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is likely to be Low to Moderate, with the most likely in the immediate term from the complex region on the southwest limb, AR3380. Two other moderately large regions AR3386 and AR3382 in the northwest and northeast respectively, also contribute most of the risk of any further M-class flares.

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Met Office Space Weather Technical Forecast

Solar Wind / Geomagnetic Activity: A couple of side glancing CMEs may affect Earth on Day 1 (4th Aug), but perhaps into Day 2 (5th Aug). A more direct hitting CME is expected to impact Earth late day 2 or into day 3 (6th Aug). Solar winds at slow-ambient levels to start, perhaps becoming slightly elevated 400-500km/s into the period due to transient High Speed Stream (HSS) effects from Coronal hole influences and potential CME influence. Low confidence in details. Geomagnetic activity is expected to be Quiet (Kp 0-2) to start day 1 (3rd Aug), becoming Unsettled to Active (Kp 3-4) with a chance of G1/Minor Geomagnetic Storm intervals from late Day 1 through until Day 3, then probably returning to Quiet to Unsettled (Kp1-2) levels by Day 4 (7 Aug).

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is currently at background levels. There is a slight chance of enhancement from any notable flares that occur, most likely emanating from AR3380 in the near term. The high energy electron flux (greater than 10 MeV) is expected to remain at normal background to moderate levels through the period. The associated fluence therefore remaining below the Active threshold (1e8 total pfu).

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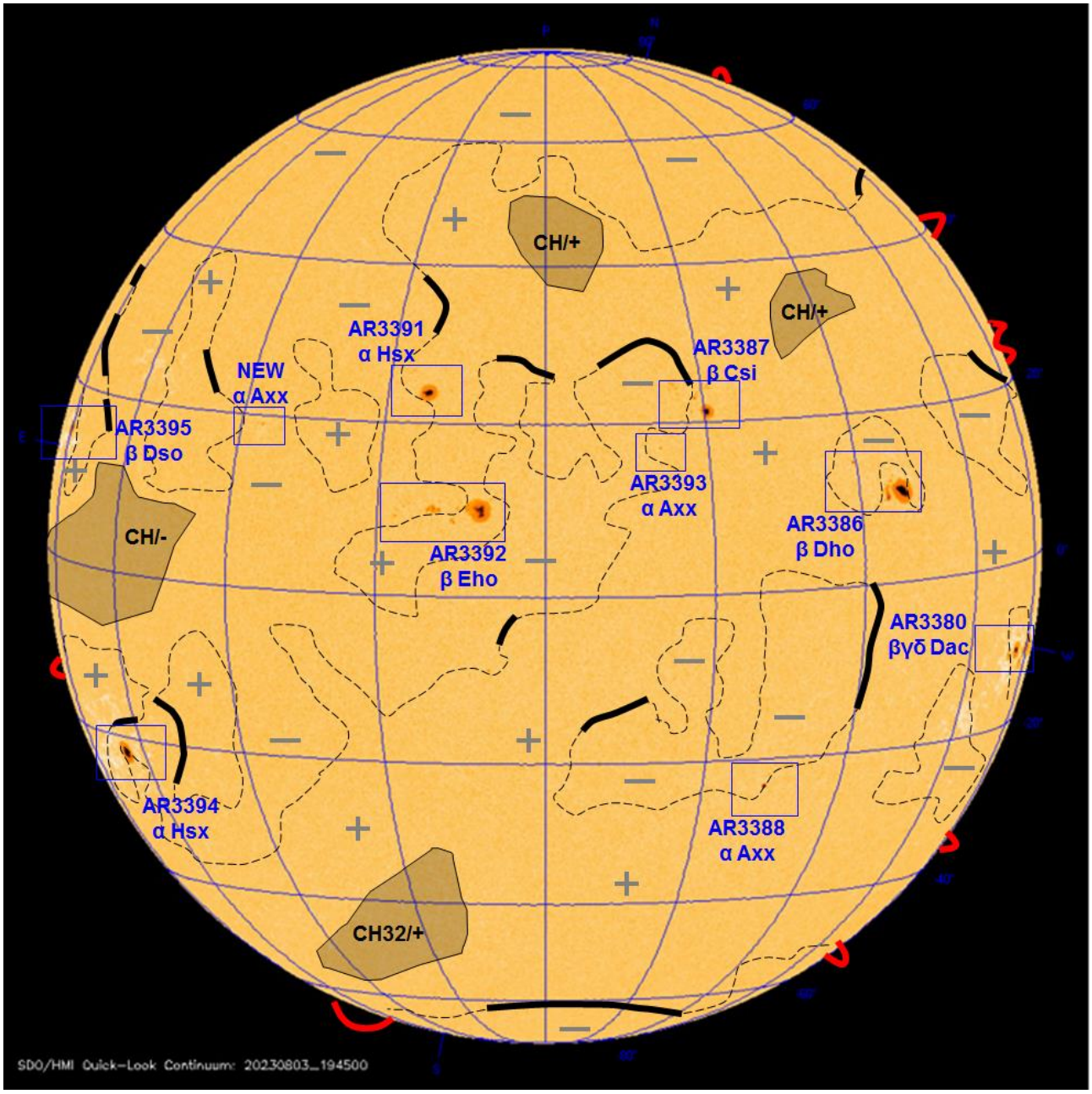
Figure 1. Solar Analysis Valid 2000 UTC, 3 August 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A solar filament lifting off the sun's surface was observed centre disc around 31/1800 UTC, alongside a C5 flare from AR3380 with a probably associated CME appearing towards the southwest. In addition, two filament lift offs from the northeast disc produced a CME towards the northeast. Both of these are considered to have an Earth directed component, with arrivals anticipated on Day 1 (04 Aug), but possibly early on Day 2 (5th Aug). Low confidence due to lack of Stereo-A imagery available for analysis. In addition to these two CME, a full-halo CME left the Sun around 02/0900 UTC. This is considered to arrive Day 2 or perhaps early into day 3 (6th Aug). Solar winds are currently slow-ambient, with the potential for some further minor enhancement from connection to a weak high speed stream (HSS) from either CH31/- or perhaps an unnumbered CH/+ in the northwest disc. Both these features are low confidence however they are coincident with more well defined and likely stronger coronal holes on the previous rotation. Any enhancement from these features may occur for the next 24 hours otherwise solar winds probably generally waning. By Day 2 into Day 3 there is the increasing chance of CME impacts most reliably from the 02/0900 UTC CME, and these could see solar winds reaching 500-550km/s, particularly if they combine with HSS enhancement. Geomagnetic activity starting Quiet (Kp 0-2) on day 1 (4th Aug), becoming Unsettled to Active (Kp 3-4) with a chance (20-40%) of G1/Minor Storm intervals from late Day 1 into Day 3.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	40	5
Strong	G3	No	1	5	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/0701	Partial	Filament eruption	NE	599 km/s	04/0300 UTC	Glancing blow
01/0827	Partial	Filament eruption	SW	424 km/s	04/1400 UTC	Glancing blow
02/1600	Full	Filament eruption	Centre disc	520 km/s	05/2359 UTC	Direct hit possible

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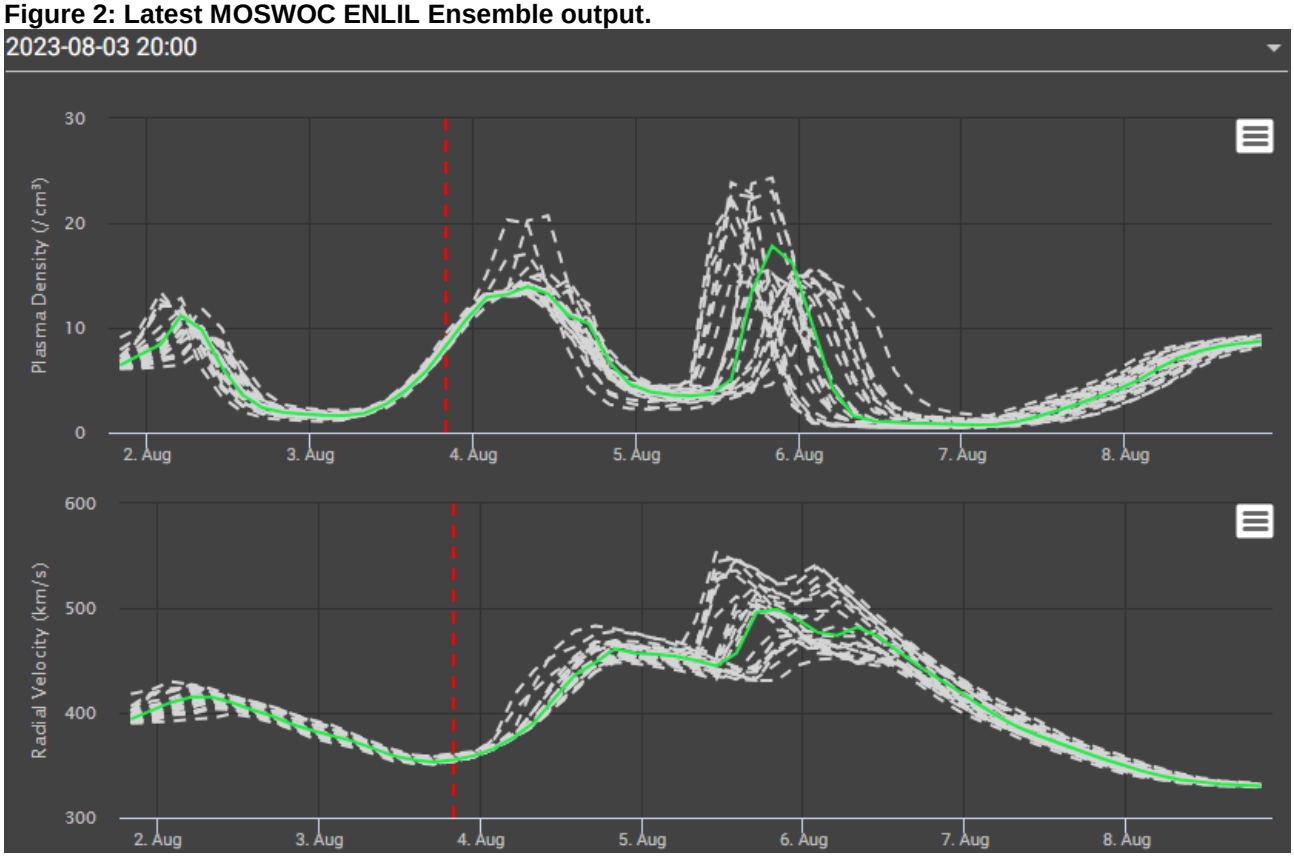
Figure 2: Latest MOSWOC ENLIL Ensemble output.



Radio Blackouts - X-Ray Flares:

Nine numbered and one un-numbered sunspot region feature on the visible disc. The largest region is AR3380 (Dac/Beta-Gamma-Delta) on the southwest limb and remains unchanged. AR3386 in the northwest and AR3392 in the northeast are both the second largest regions and have also seen little significant change in recent hours, with minor reorganisation of the intermediate spots in both regions. New region AR3395, emerging across the northeast limb, is showing some signs of complexity and is marked as Dso/Beta and classification will probably change as it rotates further into view. Remaining regions appear generally stable or in decay. Activity is likely to be Low to Moderate, with the most likely in the immediate term from the complex region on the southwest limb, AR3380. Two other moderately large regions AR3386 and AR3382 in the northwest and northeast respectively, also contribute most of the risk of any further M-class flares. The arrival of further active regions across the eastern limb is anticipated to be most probable later in the period, and probabilities have been held at similar levels, although the most likely scenario is for probabilities to drop further in coming days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

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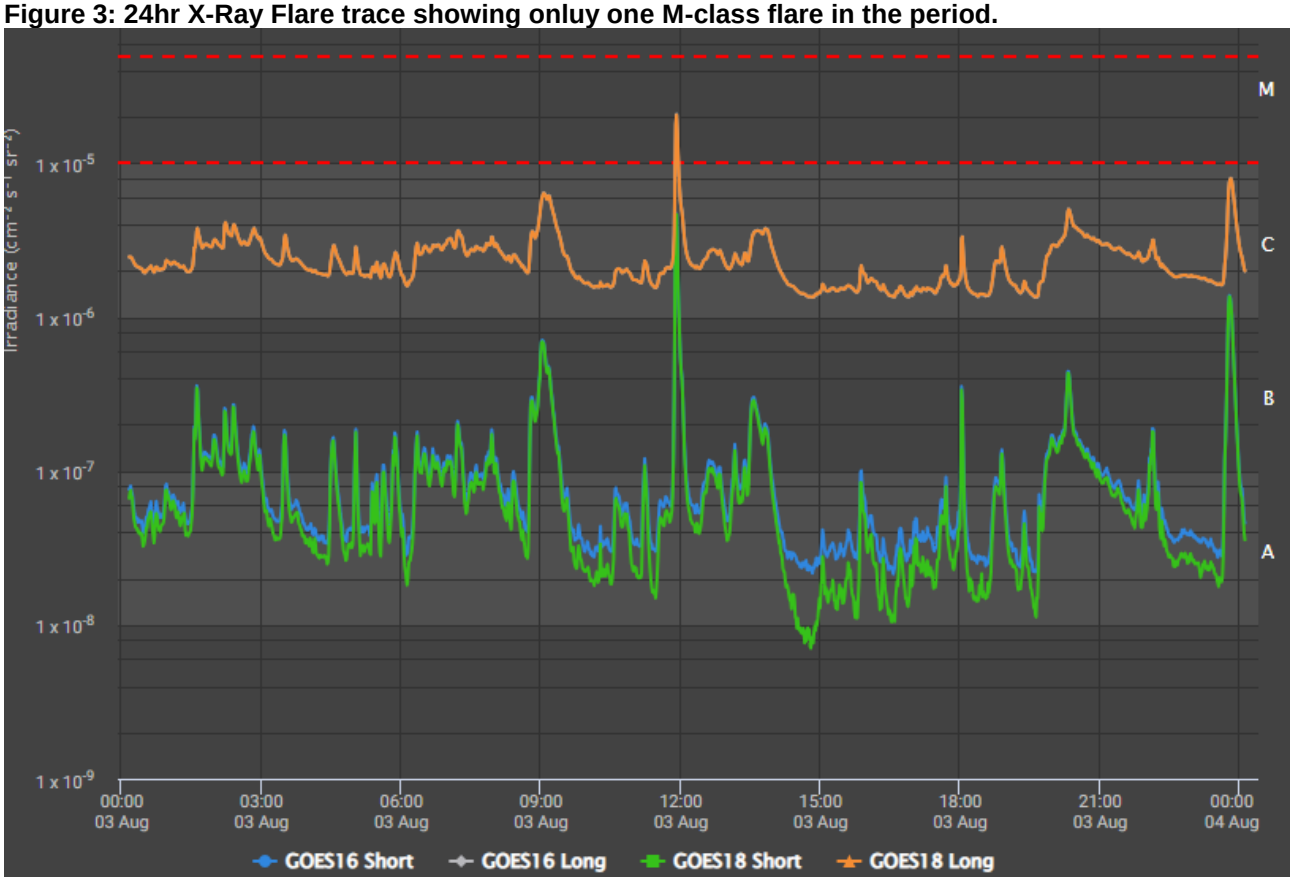
Figure 3: 24hr X-Ray Flare trace showing onluy one M-class flare in the period.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is at background levels. The main risk of enhancement and exceedance of the S1/Minor Storm threshold, comes mostly from the complex region AR3380 on the limb of the southeastern edge of the visible disc. This risk is continued into first two or three days of the guidance period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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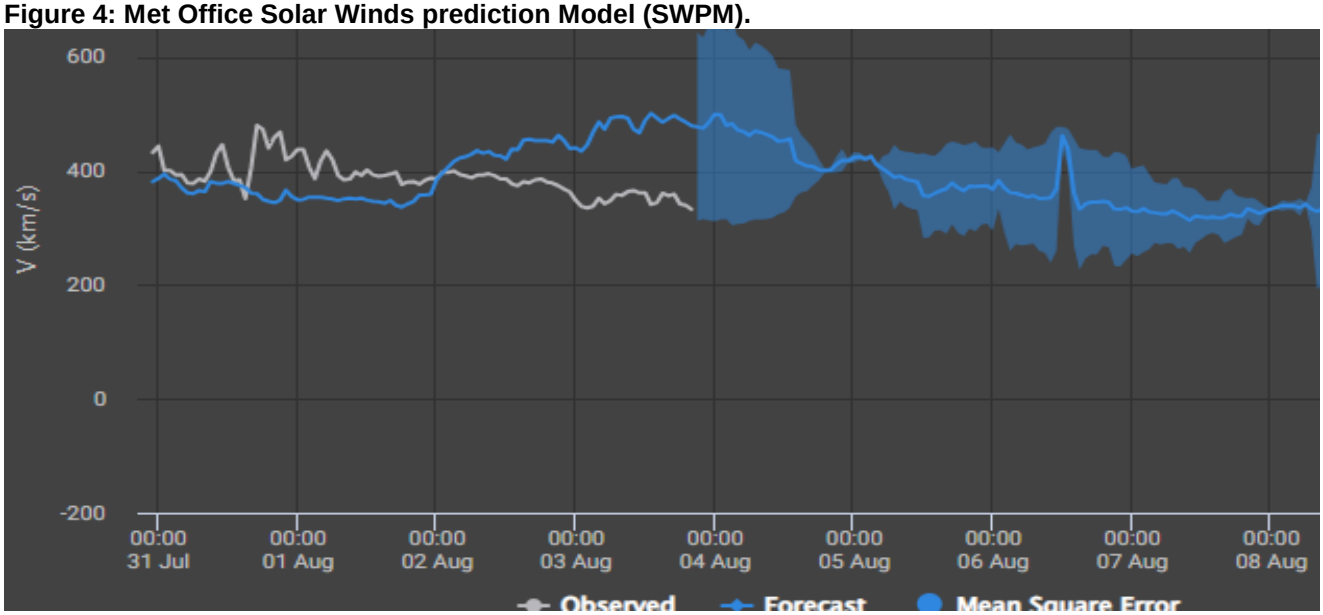
Figure 4: Met Office Solar Winds prediction Model (SWPM).



High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 10 MeV) is currently expected to remain at normal background to moderate levels through the period, as CME potential and the lack of significant high speed streams leading to suppressed flux values.

The associated 24 hour fluence is forecast to remain below Active (1e8 total pfu). The Met Office REFM output is currently giving reasonable guidance for initial conditions, but confidence in the model falls as the period advances.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	10	10	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: High energy electron flux at GEO and MOSWOC REFM output.

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